PTO 08-5879

CC=DE DATE=20030410 KIND=A1
PN=10146612

TENSIONER
[SPANNVORRICHTUNG]

MICHAEL BOGNER, et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
Washington, D.C. June 2008

Translated by: FLS, Inc.

PUBLICATION COUNTRY	(10): DE
DOCUMENT NUMBER	(11): 10146612
DOCUMENT KIND	(12): A1
PUBLICATION DATE	(43): 20030410
APPLICATION NUMBER	(21): 10146612.9
APPLICATION DATE	(22): 20010921
INTERNATIONAL CLASSIFICATION	(51): F16H 7/08
PRIORITY COUNTRY	(33): NA
PRIORITY NUMBER	(31): NA
PRIORITY DATE	(32): NA
INVENTOR(S)	(72): BOGNER, MICHAEL; KRAUS, MANFRED
APPLICANT(S)	(71): INA-Schaeffler KG
DESIGNATED CONTRACTING STATES	(84): NA
TITLE	(54): TENSIONER
FOREIGN TITLE	[54A]: SPANNVORRICHTUNG

Specification /1[*]

[0001] The present invention concerns a tensioner for a traction element, in particular a belt of a traction drive. The object of the tensioner here is to assure non-slipping driving of all components, respectively accessories that are driven with the traction element, both in starting operation and in generator operation.

[0002] In particular, tensioners of this type are used in internal combustion engines for motor vehicles. The traction drive here is driven by the engine crankshaft and connects individual pulleys of the components, respectively accessories to be driven. Internal combustion engines are frequently provided with two traction drives, a first traction drive of the control drive being provided for driving the camshaft or camshafts. A second traction drive, also called an accessory drive, is used for driving, for example, the water pump, the injection pump, the air conditioning compressor, servo devices, and other accessories. Increasing lengths of the traction element and uneven rotation of the crankshaft, caused by the combustion process of the internal combustion engine, produce dynamic effects, in particular vibrations of the traction element. Moreover, the material of the traction element undergoes a temperature-based change, whereby the tightening force of the traction element, the belt tension, changes especially at high or low limiting

[*]Claim and paragraph numbers correspond to those in the foreign text.

temperatures. Belts tend to stretch because of aging and wear so that the initially set tension of the traction element decreases.

[0003] DE 198 45 710 A1 discloses a tensioner, the base part of which is permanently mounted on a machine part. A swivel arm is connected with the base part via a rotation axis. On the free end the tension arm is elastically supported on the traction element via a rotatable tension roller. In the area of the rotation axis, one end of the pin is provided with a radial flange, a friction lining or friction disk, that, operating as a damping element, damps an adjusting motion of the swivel arm, being located between end surfaces of the radial flange and the hub of the tension arm.

[0004] The tensioner according to DE 43 43 429 A1 is permanently, but detachably, fastened to a housing of the internal combustion engine. A rotation axis provided between the base part and the swivel arm is externally surrounded by a torsion spring, a first spring end being secured to the base part and the other spring end to the swivel arm. The torsion spring here surrounds a central portion of the base part, in which the bearing pin of the tension arm can swivel via a bearing made as a slide bearing sleeve. A radial flange mounted on the end side of the bearing pin, which is supported by an end face of the base part via a friction lining which simultaneously serves as a damping element, is used for axial support of the swivel arm on the base part. A rotatable tension roller, which elastically

rests against the traction element, is provided on the free end of the swivel arm.

[0005] Tensioners of this kind are provided in order to assure the most uniform, non-slip tensioning of the traction element. The measures provided for this cause a constant, uniform tensioning force of the traction element without influencing the speed level of the traction element drive.

[0006] It is desirable to reduce the tension force of the traction element at high speeds and to increase it at low speeds, adjusted to the respectively required moment for driving the accessories. The known tensioners are designed for a maximally transmittable torque of the accessories, e.g. 100% generator load, which causes an excess tension force in the case of reduced loading by the accessories, in particular when the internal combustion machine is idling. The required tensioning force is below the resulting tensing force. The traction drive thus is overly tight. On the other hand, too low a tightening force at high torques leads to increased slipping between the traction element and the belt pulleys. Consequently, in the known tensioners in each case a compromise must be made in order to obtain, on the one hand, the dynamic effects and the slipping, and, on the other hand, to control the noise development.

Summary of the invention

[0007] Taking account of the disadvantages of the known solutions, therefore the object of the invention is to obtain a tensioner with which a constantly adjusted tensioning force of the element, respectively the belt, can be obtained irrespective of the speed level of the loading of the accessories and the operating phase of the internal combustion engine.

[0008] In order to solve this problem the invention provides for a tensioner, an actuator or a control element being located between the machine element and the base part. The actuator is designed so that it has an adjustable or variable effective length. Therefore it is possible to obtain a tightening of the traction element adapted to the respective operating state of the internal combustion engine, in which the actuator or the control element adjusts the tensioner. An adjustable or variable effective length of the actuator makes a desired adjustment of the tension of the traction element possible. In this case it is advantageous to be able to influence the effective length of the actuator so that the tightening force in the traction drive can be adjusted to the respective revolutions per minute or speed of the traction element and/or the respective operating phase of the internal combustion engine. For this, the actuator or the control element is provided with means for controlling/or regulating the effective length. Unlike existing tensioners that usually are always designed for the maximum load, which results in considerable reductions of the belt service life, the tensioner according to the

invention avoids excess tension of the traction element or belt. Thus it is possible to achieve the increased tightening force of the traction element required in the starting phase or in the case of high unit loads, as well as a reduced tightening force in the case of low loads of the accessories. The invention thus fulfills the requirements of the vehicle manufacturer, respectively the customers, for an extended service life of the belt and thus the entire traction drive. In addition, a tensioning system of this kind is ideal for applications, that is traction drives, that include a belt-driven starting generator.

[0009] It is advantageous that the invention does not require great modifications of the tensioner. Conventional mechanical tensioners that usually are provided for the accessory drive of an internal combustion engine therefore can be modified without great expense with the actuator according to the invention.

[0010] Further advantageous configurations of the invention are the object of dependent Claims 2 to 12.

[0011] The invention is advantageously applicable to the traction drive of an internal combustion engine, that includes a belt-driven starter generator. This accessory fulfills two functions. During the starting process, the starter generator operating as an electric motor drives the internal combustion engine. Subsequently, while the internal combustion engine is running, the starter generator switches to generator operation, in which the accessory

provides electric energy for the on-board electrical system of the motor vehicle. Depending on the operating mode of the internal combustion engine, a torque is introduced from the starter generator or the internal combustion engine via the respective pulleys into the traction element. Connected with this there is an alternation of the return strand and the pulling strand, respectively a change in the torque direction in the traction element between the belt pulleys of the crankshaft and the starter generator. A high tightening force of this kind in the traction element can also be obtained in the starting mode by means of using the actuator according to the invention, by means of which slip-free, brief, rapid starting of the internal combustion engine is assured.

[0012] A preferred configuration of the invention provides an electronically regulated system, the actuator being controlled in response to at least one parameter influencing the belt tension. As an alternative to this, the invention also includes a mechanically performed control, respectively regulation of the tightening force of the traction element, with which the tightening force, respectively the accessory load, of the traction element, respectively the belt, can be adjusted to the corresponding operating phase of the internal combustion engine.

[0013] In a preferred embodiment the electronic system is made so that the latter changes the effective length of the actuator and thus directly influences the tightening force of the traction

element, depending on at least one of the parameters, such as generator output, tensioning force of the traction element, effective direction of the torque in the traction element, or the speed of a belt pulley. Furthermore, according to the invention, the effective length of the actuator can be determined in relation to a reset moment of an electric motor that is used, for example, for driving a ball screw drive. The high generator output established in the start-up mode is directly converted here in order to shift the actuator and thus the tensioner into a position that increases the tightening force of the traction element. The parameters can be determined according to the invention by sensors or alternative devices.

[0014] The actuator, respectively the control element, according to the invention may be designed so that this component assumes two positions, that is, a retracted and an extended position. Alternatively, it is possible to use an actuator that makes an infinitely adjustable effective length possible. An actuator, that includes a ball screw drive, is particularly suitable. The ball screw drive driven by an electric motor makes it possible to precisely adjust the effective length of the actuator.

[0015] Alternatively it is also possible to use an actuator that is made as a hydraulically or pneumatically, respectively electrohydraulically or electromagnetically, acting control element.

[0016] According to the invention, the base part of the tensioner can be swiveled via a swivel bearing with respect to the

machine element into a certain angular range by means of the actuator. The tightening force of the traction element furthermore can be influenced by a variation of the geometric position of the swivel bearing for the base part. In the case of a corresponding position of the swivel bearing the invention makes an approximately constant position of the tension roller possible, constant, regardless of the effective length of the actuator, but with an influence on tightening force of the traction element. This measure is helpful in particular in starter generator mode, whereby it is possible to obtain a high tightening force of the traction element, which may theoretically go on endlessly, as long as the resultant lever arm approaches zero, without the position of the tension roller changing. The position of the swivel bearing for the base here agrees with the swivel point of the tension roller. As a result of this positional agreement, there is no resulting lever arm between the swivel points of the base and the tension roller.

[0017] As an alternative to an actuator directly attached to the base part of the tensioner, an indirect connection also is provided according to the invention. A toggle lever, the ends of which are attached to the machine element and the base part, is particularly suited for this, and the actuator is attached in the area of the toggle lever. This measure enables transmission of the actuator force, which is advantageously reflected in the design of the actuator, respectively the amount of the adjusting force.

Advantageously, a stop is provided for the toggle lever, by means of which it is possible to precisely position the latter in an end position. This measure produces a definite position of the toggle lever and base part of the tensioner connected therewith.

Brief description of the drawings

[0018] The invention is described in greater detail by means of some embodiments. Here:

[0019] Fig. 1 shows a tensioner provided with an actuator according to the invention in a neutral position;

[0020] Fig. 2 shows the tensioner depicted in Fig. 1 with an extended actuator;

[0021] Fig. 3 shows an alternative to the tensioner depicted in Fig. 1, in which the swivel bearing of the base part agrees with the swivel axis of the tension roller;

[0022] Fig. 4 shows the tensioner according to Fig. 3 in an extreme position with an extended actuator;

[0023] Fig. 5 shows the arrangement of an actuator that is connected with the tensioner via a crank lever;

[0024] Fig. 6 shows a tensioner with a mechanically-hydraulically operating control and/or damping element, the base part of which can be swiveled by means of an actuator;

[0025] Fig. 7 shows a tensioner corresponding to Fig. 3 as far as possible, provided with an actuator designed as a ball screw drive;

[0026] Fig. 8 shows a longitudinal section of the structure of a known swiveling device.

Detailed Description of the Drawings

[0027] The invention concerns an addition to a known tensioner 1, that is shown in a longitudinal section according to Fig. 8. The construction includes a base part 2 that is permanently attached to a machine element 3. The base part 2 is made in one piece with an axially extending cylindrical pin 4 which is surrounded radially and concentrically by a hub 5. A friction or bearing sleeve 7, designed as a sliding bearing is inserted in an annular gap 6 limited by the hub 5 and the pin 4, for forming a rotation axis 8 that agrees with an axis of symmetry 15. The hub 5 is a component of a swivel arm 9, on the free end of which there is a rotatably mounted tension roller 10 supported on a traction element 11, the tension roller 10 forming the rotation axis 16, that is separated by the radius “r” from the axis of symmetry 15. A torsion spring 12 surrounding the rotation axis 8 used between the base part 2 and the swivel arm 9, causes a force-locking, elastic mounting of the tension roller 10 on the traction element 11. A ring flange 13 fixed in position on the end of the pin 4 is used for axial force exerted by the torsion spring 12. In this case the hub 5 is supported via a sliding disk 14 on the ring flange 13, this base part simultaneously assuming the function of a damping element.

[0028] Figs. 1 to 7 show tensioners that agree at least partially with the tensioner 1 depicted in Fig. 8. The different base parts of the tensioners are described below.

[0029] The tensioner 21 shown in Fig. 1 is provided with a swivelable base part 22, which can swivel around a rotation bearing 24 with respect to the machine element 23. The mounting of the tension roller 10 on the swivel arm 9, not shown in Fig. 1, is designed in agreement with the tensioner 1 depicted in Fig. 7. An actuator 25, that is attached on the opposite side hinged to the machine element 23, is hinged on the base part 22 separated from the rotation bearing 24. This actuator 25, also called control element, has a variable effective length “s” and thus makes it possible to directly influence the tightening force of the traction element 11. The geometry of the entire arrangement can be varied, in connection with a direct influence on the tightening force of the traction element 11, by the swivel bearing 24, respectively housing swivel point of the tensioner 21 combined with the above-mentioned actuator, permanently connected with the machine element 23, respectively the housing of an internal combustion engine.

[0030] The tensioner 21 has two lever arms, lever arm “R” between the swivel bearing 24 of the base part 22 and the swivel point 26 of the actuator 25 on the base part 22, and lever arm “r” between the rotation axis 16 of the tension roller 10 and the symmetry axis 15 of the base part 22. These two lever arms “R” and

"r", differing from one another, result in a variable, effective lever arm "I_1" by variation of "R". Moreover, Fig. 1 symbolically shows a starter generator 30 that is connected via a belt pulley 38 with the traction element 11 and thus with the traction element drive. Depending on the operating mode, the starter generator 30 performs a start-up function or a generator function. In this case, this accessory alternates between driving and being driven. Correspondingly, there is also an alternation of return strand and pulling strand between the pulleys 38, 39 of the starter generator 30 and the crankshaft 40 of an internal combustion engine not shown in Fig. 1.

[0031] Fig. 2 shows the tensioner 21 in a bearing position that is changed in comparison with Fig. 1, produced by the extended actuator 25. This changed position has a changed effective lever arm "I_2"

[0032] that is shortened in comparison with lever arm "I_1". At the same time the tension of the torsion spring 12, which is mounted in the tensioner, is increased. The actuator 25 includes an electric adjustment drive 27 which makes a continuous adjustment of the tensioner 21. The control drive includes an electronic control 28 that includes at least one sensor 29 that influences the tightening force of the traction element 11 depending on at least one parameter. The electronic control 28 takes account, for example, of generator power, operating direction of the torque in the traction element 11,

the tightening force of the traction element 11, or the rotation speed of a belt pulley of the traction drive and transmits a signal to the electronic system 28, with which the adjustment drive 27 can be controlled. Alternatively, the reset element of the electric motor that is connected with a ball screw drive can be evaluated.

[0033] Figs. 3 and 4 show the tensioner 31 in two different positions. As opposed to the tensioner 21 according to Figs. 1 and 2, the tensioner 31 includes an approximate positional agreement of the rotation axis 16, the tension roller 10, and the swivel bearing 34 of the base part 32, at least in a nominal position of the tensioner 31. As Fig. 4 makes clear in the case of an extended actuator 35, the position of the tension roller 10 is approximately unchanged as compared with Fig. 3. The unchanged position of the rotation axis 16 of the tension roller 10, irrespective of the effective length "s" of the actuator 35, has the result that the tightening of the torsion spring is not changed but only the effective lever arm varies.

[0034] Depending on the position, a lever arm length near zero can be set, so that a quasi-rigid tension roller 10 is established. A tension roller 10 of this kind does not form a resultant lever arm, by which a high tightening force of the traction element 10 [sic], which can be infinite, can be obtained, without shifting the rotation axis 16 of the tension roller 10. Thus the rotation of the base part 32 causes a changed tightening of the belt drive 12, by which a high increase in the tightening force in the traction element 11 can be

realized. A tensioner 31 of this kind is suited, in particular, for use as a starter generator. The required increased tightening force in the traction element 11 can be obtained while retaining the geometrical relations, in particular the looping angle of the traction element 11 on the respective belt pulleys of the traction drive.

[0035] Fig. 5 shows the tensioner 31, the actuator 35 of which is hinged directly to the base part 32 via a toggle lever 33. Thus a powered arrangement of the actuator 35 connected with the tensioner 31 is established. A stop 37 is provided for reaching a defined end position in the extended position of the toggle lever 33.

[0036] Fig. 6 shows the tensioner 41, which includes, instead of a torsion spring, a hydraulically mechanical control element 47 of known construction, that secures a spring-mounted tightening roller on the traction element 11. In this case the swivel arm 49 is connected with the base part 42 via a swivel axis 48. The hydraulically mechanical control element 47 hinged to the base part 42 is attached to the swivel arm 49 offset to the swivel axis 48. Furthermore, the tensioner 41 includes a swivel bearing 44 that makes it possible for the base part 42 to swivel with respect to the machine element 43. In this the actuator 45 performs the adjusting motion of the base part 42.

[0037] The tensioner 51 shown in Fig. 7 shows the actuator 55 designed as a ball screw drive 50. This design includes a rotatable

threaded spindle 53 in each case mounted on the ends, which is driven by an electric motor. The rotation of the threaded spindle 53 causes an axial displacement of a nut 54 form-fittingly mounted onto the threaded spindle 53 depending on the direction of rotation. A lever 52, via which the adjusting motion of the nut 54 can be transmitted to the base part 32, and with this the tightening force of the traction element 11 can be influenced by means of the swivelable base part 32, is hinged between hinge point 36 of the base part 32 and the nut 54. A ball screw drive 50 designed in this way avoids a direct transmission of the tightening force to the nut 54. Rather, the tightening force is introduced as a bending moment into the threaded spindle 53. In connection with this, a smaller driving moment of the threaded spindle 53 is established, that is, the electric motor used for driving the threaded spindle 31 requires a relatively small holding curren

Reference numbers

1 tensioner

2 base part

3 machine element

4 pin

5 hub

6 ring gap

7 friction sleeve

8 rotation axis

9 swivel arm

10 tension roller

11 traction element

12 torsion spring

13 ring flange

14 sliding disk

15 symmetry axis

16 rotation axis

21 tensioner

22 base part

23 machine element

24 swivel bearing

25 actuator

26 swivel point

27 adjusting drive

28 control

29 sensor

31 tensioner

32 base part

33 toggle lever

34 rotation bearing

35 actuator

36 belt pulley

37 stop

38 belt pulley

39 belt pulley

40 crank shaft

41 tensioner

42 base part

43 machine element

44 rotation bearing

45 actuator

46 hinge point

47 control element

48 rotation axis

49 swivel arm

50 ball screw drive

51 tensioner

52 lever

53 threaded spindle

54 nut

55 actuator

Patent Claims

1. A tensioner for a traction element (11), in particular a belt of a traction drive for an internal combustion engine:

a tensioner (21, 31, 41, 51) having a base part (22, 32, 42), that is connected via a rotation axis (24, 34, 44) with a swivel arm (9, 49), on the free end of which a rotatable tension roller (10) supported on the traction element (11) being located;

a spring element acting on the swivel arm (9, 49) assuring force-locking support of the tension roller (10) on the traction element (11);

a damping element inserted between the base part (22, 32, 42) and the swivel arm (9, 49) damps an adjusting motion of the swivel arm (9, 49);

the base part (22, 32, 42) is supported via a swivel bearing (24, 34, 44) and furthermore via an actuator (25, 35, 45, 55) or a control element on the machine element (23, 43);

a tightening force of the traction means (11) is adjustable with a means of controlling and/or regulating an effective length “s” of the actuator (25, 35, 45).

2. The tensioner according to Claim 1, the traction drive provided for an internal combustion engine includes the drive of a belt-driven starter generator (30).

3. The tensioner according to Claim 1 that includes an electronic system (28), the actuator (25) being controlled taking

account of at least one parameter influencing the tightening force of the traction element.

4. The tensioner according to Claim 3, the effective length “s” of the actuator (25, 35, 45) can be influenced in particular depending on at least one of the parameters:

- generator power;
- tightening force of the traction element;
- operating direction of the torque in the traction element;
- rotation speed of a belt pulley of the traction drive;
- a reset moment of an electric motor.

5. The tensioner according to Claim 3, it being possible to adjust the actuator (25, 35, 45) in at least two positions.

6. The tensioner according to Claim 3, with a constantly positionable actuator (25, 35, 45).

7. The tensioner according to Claim 1, the actuator (55) of which includes a ball screw drive (50).

8. The tensioner according to Claim 1, the actuator of which (35, 45) is made as a hydraulically or pneumatically operating control element.

9. The tensioner according to Claim 1 with an electromagnetically or electrohydraulically operating actuator (35, 45).

10. The tensioner according to Claim 1, the base part (22, 32, 42) being located so that the geometric position of the swivel

bearing (24, 34, 44) between the base part (22, 32, 42) and the machine element (23, 43) influences the tightening force of the traction element (11).

11. The tensioner (31) according to Claim 1, the actuator (35) of which is directly connected via a toggle lever (33) with the base part (32).

12. The tensioner according to Claim 11, the toggle lever (33) being positioned against a stop (37) in one end position.

---

8 pages of drawings appended

-Blank page-

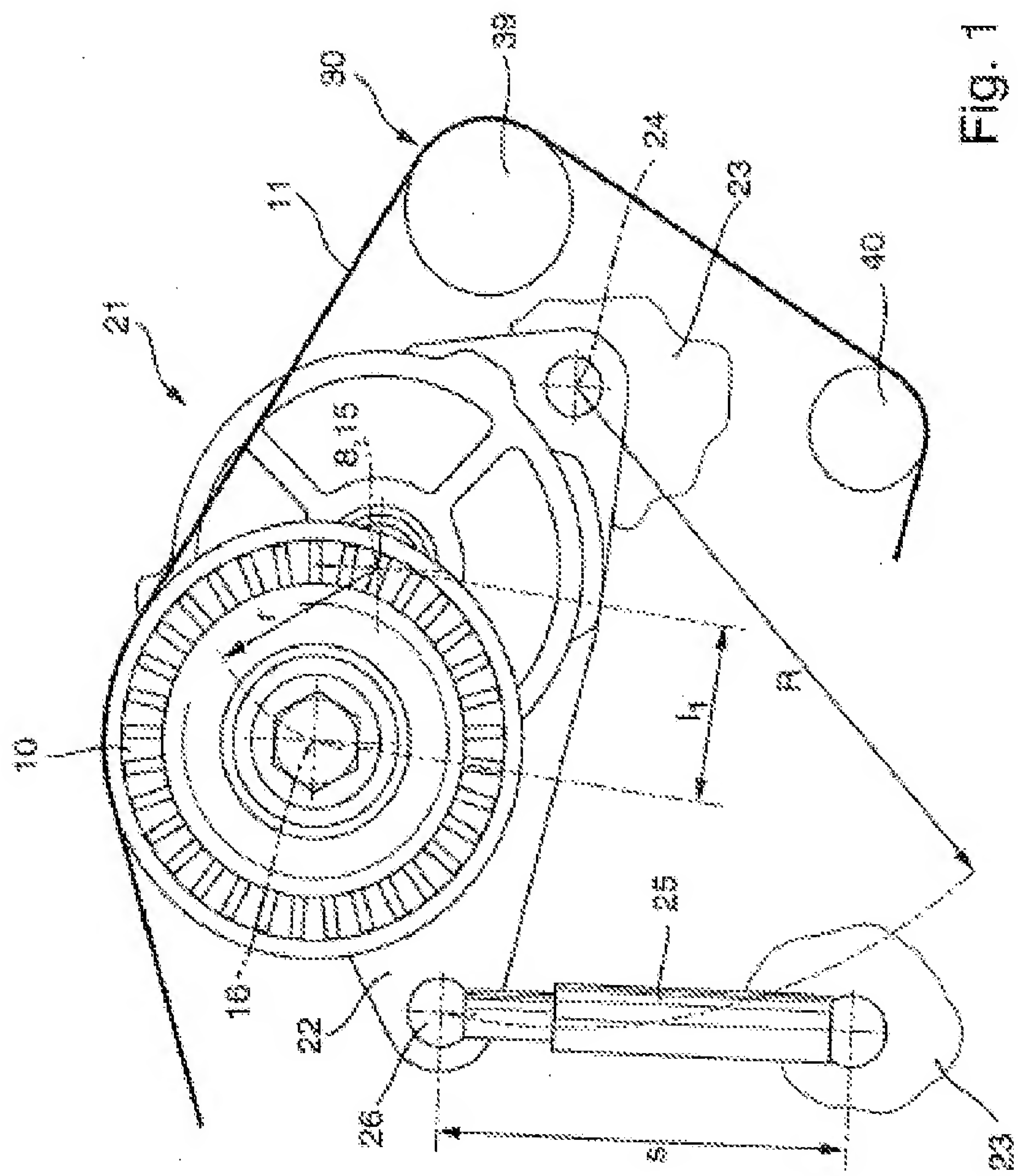

Fig. 1

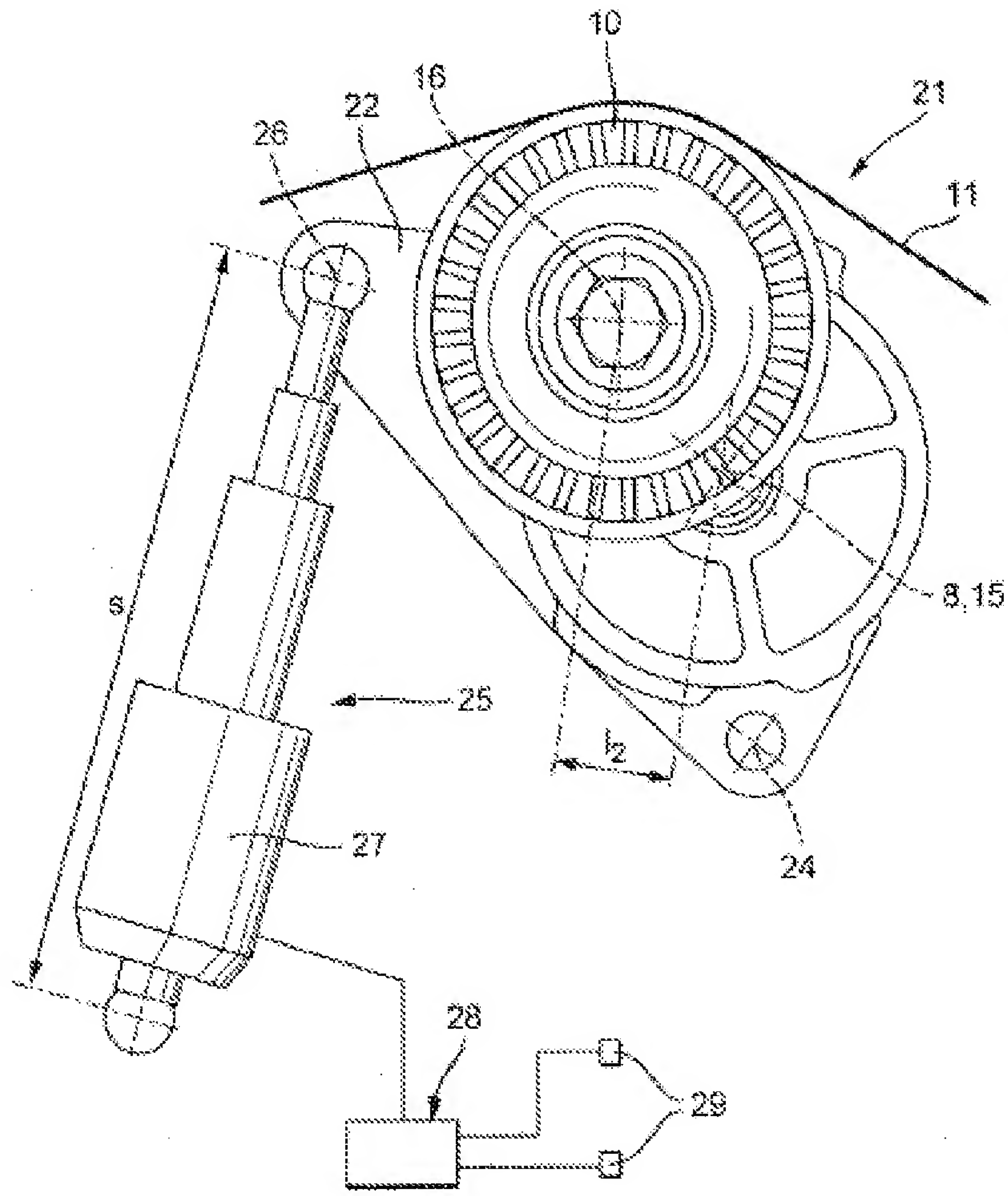

Fig. 2

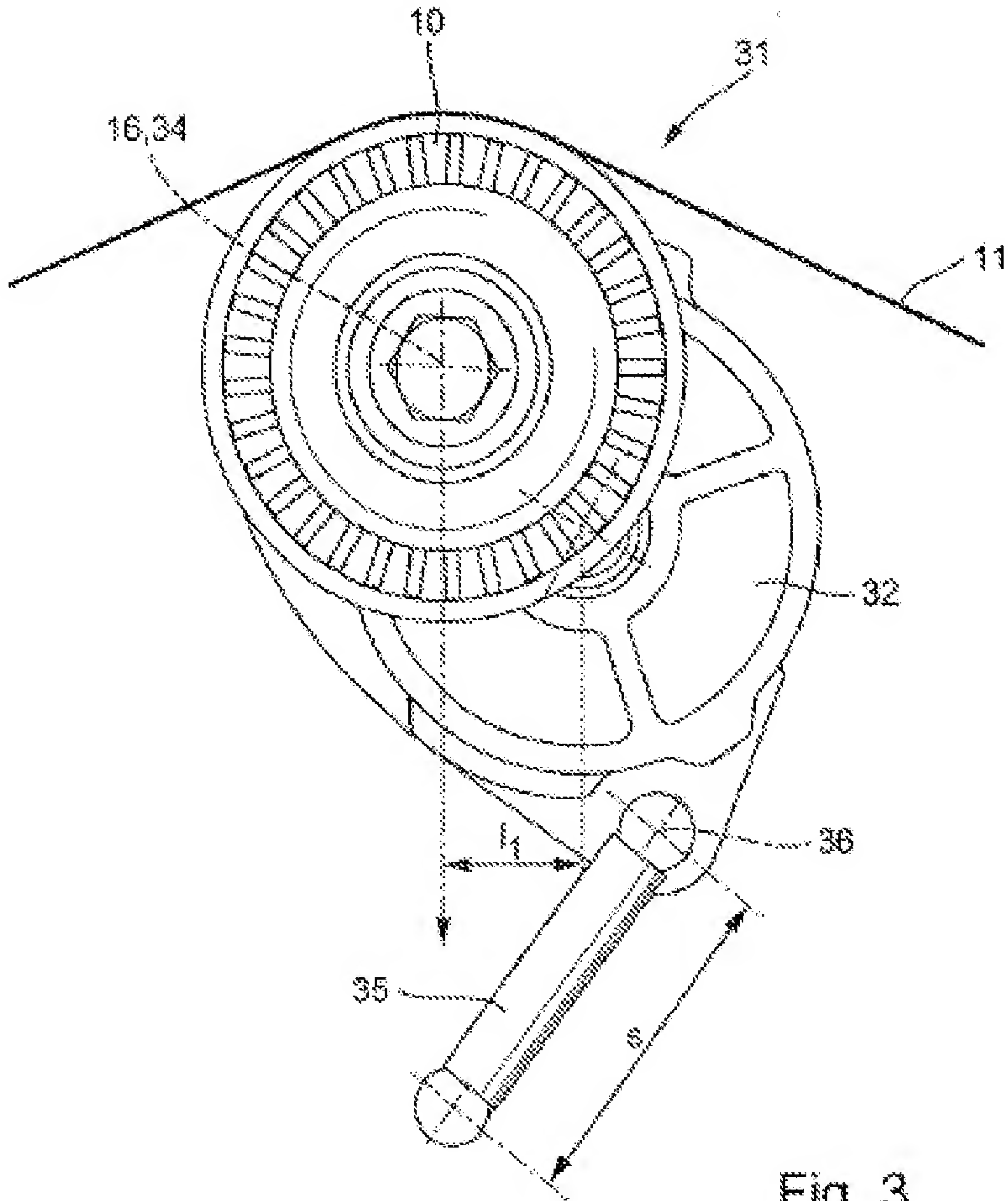

Fig. 3

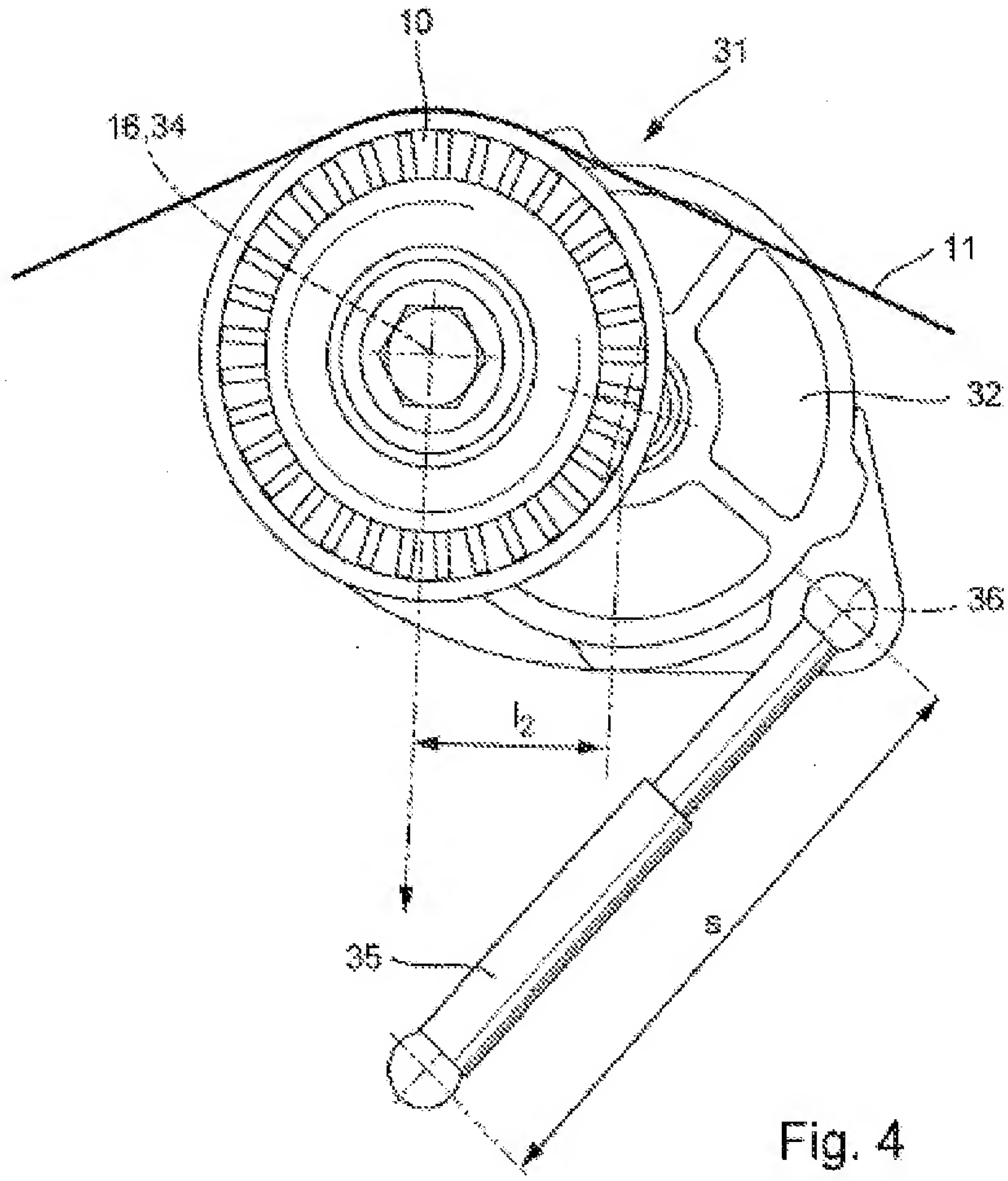

Fig. 4

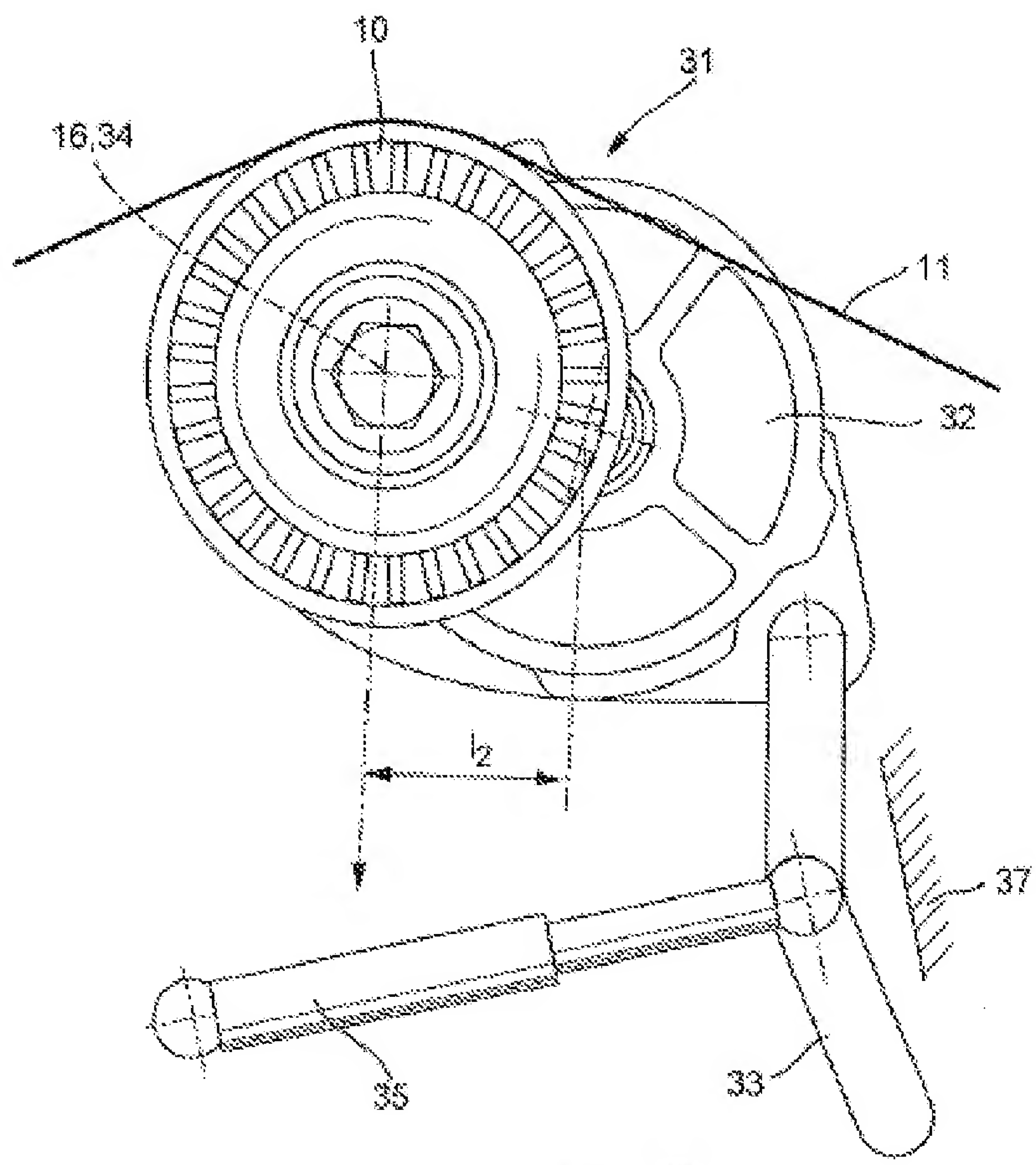

Fig. 5

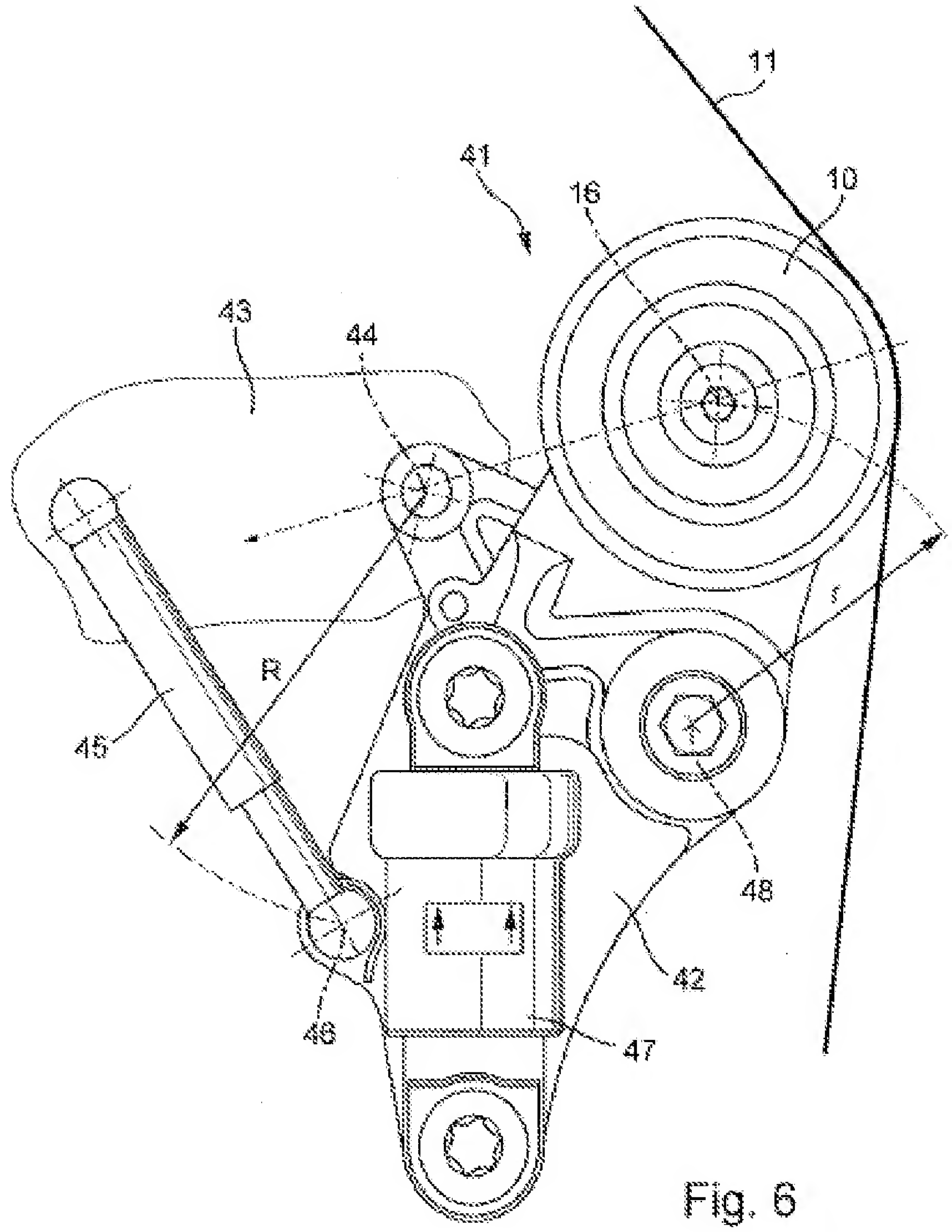

Fig. 6

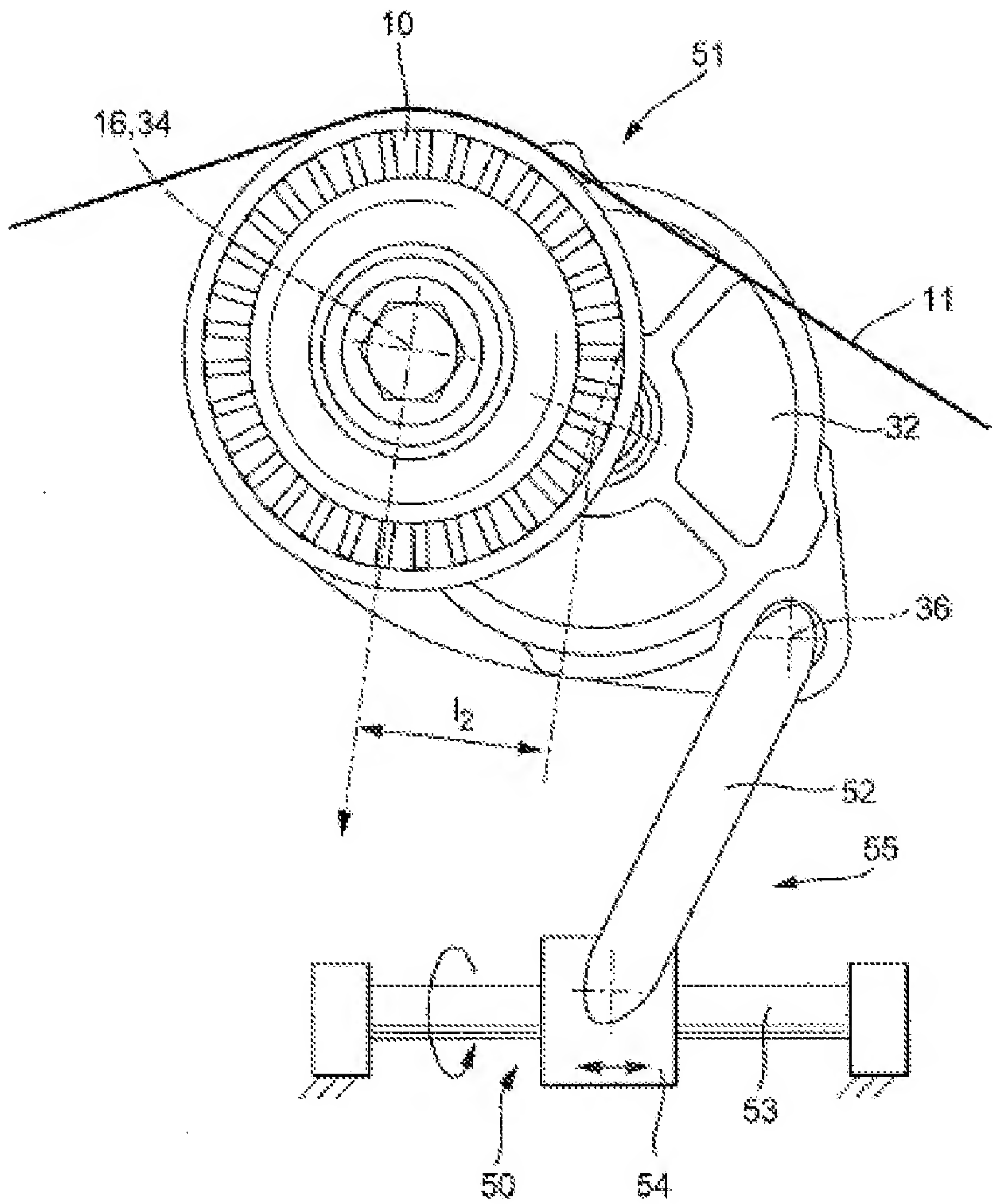

Fig. 7

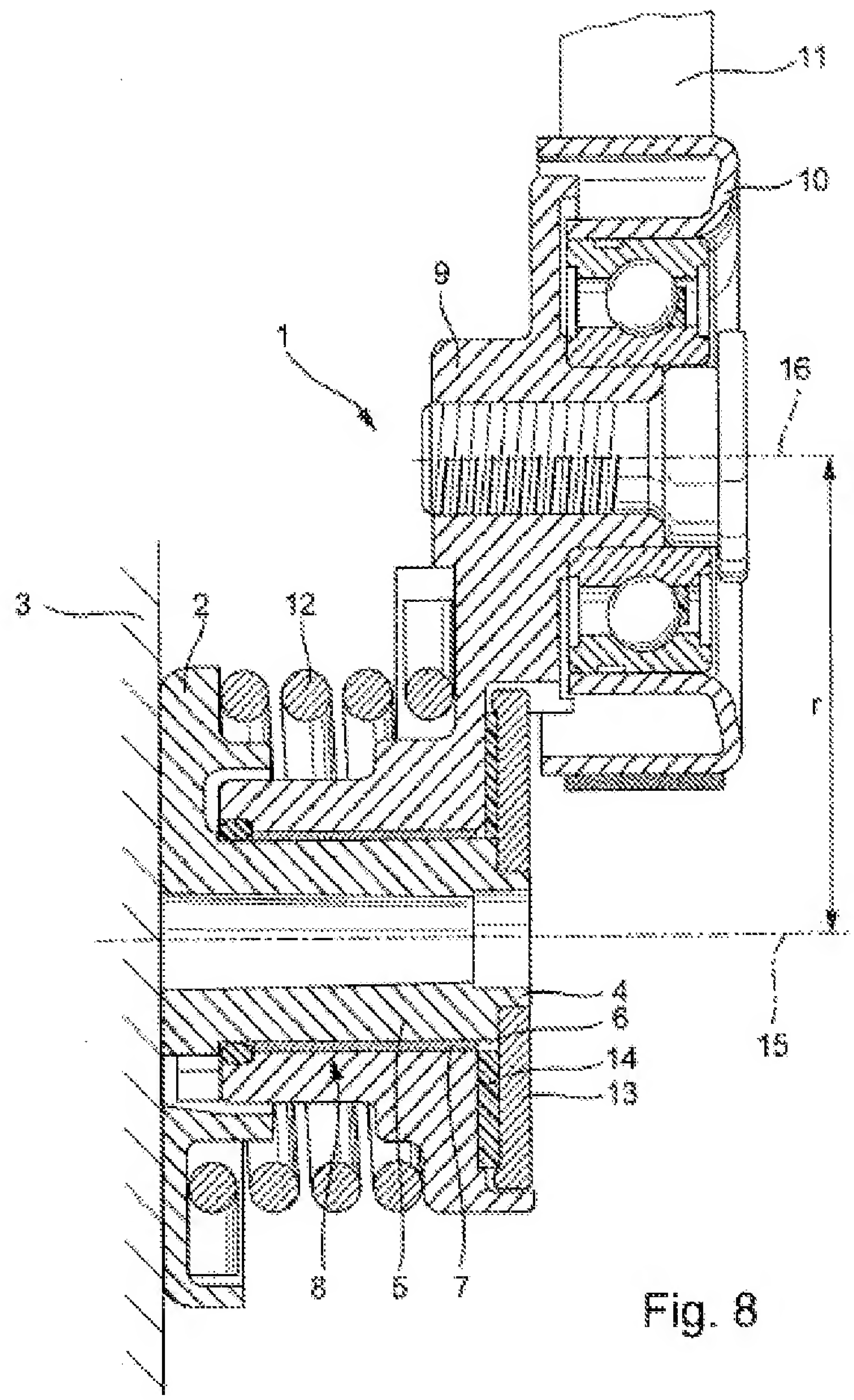

Fig. 8